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Mawmi Geology  
Beach

ON THE CHESIL BANK, DORSET.  
RAISED BEACH AT PORTLAND.

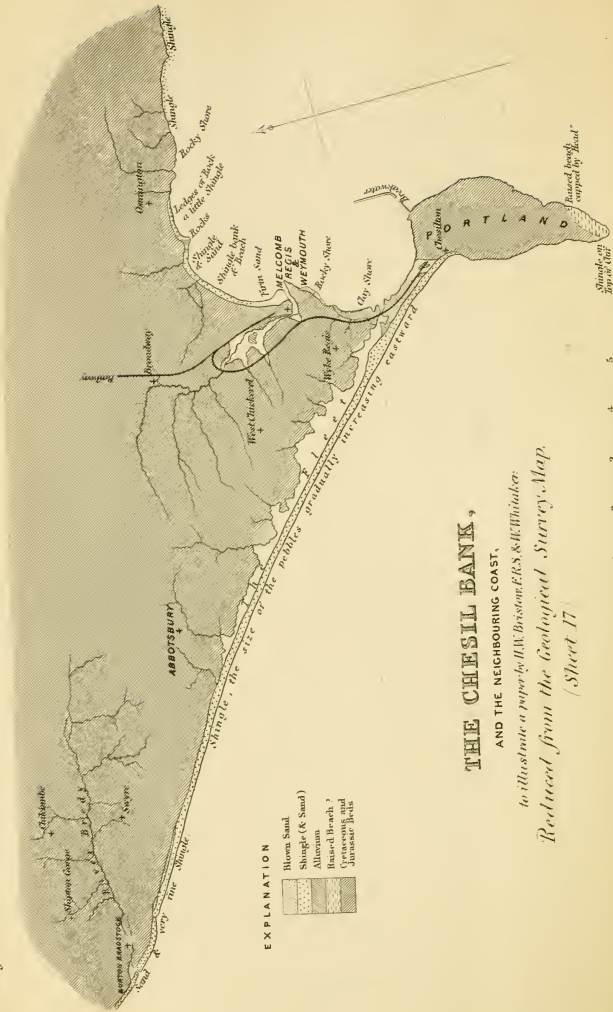
[*Extracted from the GEOLOGICAL MAGAZINE, October, 1869.*]

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Geol. May 1862.



EXPLANATION

- Blown Sand
- Shingle (& Sand)
- Alluvium
- Raised Beach?
- Cretaceous and Jurassic Beds

**THE CHESIL BANK,**  
AND THE NEIGHBOURING COAST,  
to illustrate a paper by H.W. Bristow, F.R.S. & H. Whitaker:  
*Reduced from the Geological Survey Map.*  
(Sheet 17)

Scale of Miles



*Geol. Mag.* 1869.

*Vol. VI. Pl. XV.*



*From a Sketch by H. W. Bristow, 1849.*

**VIEW OF THE CHESIL BANK AND THE "FLEET" OR "BACKWATER."**

*Looking westward from near Fleet House.*

*Engraved by G. R. De Wilde.*

## ON THE FORMATION OF THE CHESIL BANK, DORSET.

By HENRY WILLIAM BRISTOW, F.R.S., F.G.S., and WILLIAM WHITAKER, B.A.  
(Lond.), F.G.S., both of the Geological Survey of England.

[PLATES XIV. & XV.]

[A Paper read before the Geological Society of London, May 26, 1869.]

\* \* \* \* "Aloft where *Chesill*, lifts  
Her ridged snake-like sands, in wrecks and smouldring drifts,  
Which, by the South-wind raysd, are heav'd on little hills :  
Whose valleys with his flowes when foming *Neptune* fills,  
Vpon a thousand swannes the naked Sea-Nymphes ride  
Within the ouzie Pooles, replenisht every Tide :  
Which running on, the Isle of *Portland* pointeth out."

*Poly-olbion*, by Michael Drayton, Esq., Fol., Lond., 1613, p. 24.<sup>1</sup>

WE do not propose to enter into the questions of the source whence the pebbles of the Chesil Beach are derived, nor of the way in which they are heaped up ; these and other like matters having been almost exhaustively treated by Mr. J. Coode,<sup>2</sup> to whose paper we refer the reader for a detailed account of the bank. The subject with which we propose to deal is simply the cause of the formation of a long shingle-bank, separated from the mainland by a strip of water. This has not been noticed at length by any writer, as far as we know, though three theories of the origin of the bank have been brought forward.

Sir Henry De la Beche is the author of one of these. He says : "It (the Chesil bank) protects land which has evidently never been exposed to the destructive fury of the Atlantic swell and seas, which break with fury against the bank ; for the land behind is composed of soft and easily disintegrated strata, which would speedily give way before such a power. Perhaps a gradual sinking of the land

<sup>1</sup> Judging from the quaint map that accompanies this description, the Chesil bank must have been much the same in Drayton's time as now. However, all the nymphs that we saw were more or less clothed. The general appearance of the coast in question is shown in Plate XV., which is from a sketch made by Mr. Bristow twenty years ago.

<sup>2</sup> Proc. Inst. Civ. Eng., vol. xii., p. 520 (1853).

might produce the present appearances; for though the sea would have attacked the land when the relative levels were different, the form of the bay, and the projection of the Isle of Portland, would soon cause a beach to be formed, which would rise as the land sunk, so that finally no traces of a back cliff could be observed. Under this hypothesis Portland would not have formed an island, but merely the projecting point of a bay, which, with its exposure, would soon have accumulated the beach required. It may be remarked that this supposed gradual sinking of the land is in accordance with appearances more westward on the same coast, where the facts presented seem to require this explanation."<sup>1</sup>

Sir C. Lyell is the author of another theory. He says; "The formation of this bar may probably be ascribed, like that of Hurst Castle, to a meeting of tides, or to a great eddy between the peninsula and the land. . . . We may expect the slightest impediment in the course of that tidal wave, which is sweeping away annually large tracts of our coast, to give rise to banks of sand and shingle many miles in length, if the transported materials be intercepted in their passage,"<sup>2</sup> In later editions this is repeated, with the addition "or to a submarine shoal or reef between the peninsula and the land," in which form it is supported by Mr. Coode, according to whom "the isolation of the bank is due to the existence of a level, or nearly level, bench of clay, upon which the shingle is thrown and rests, as upon a shelf."<sup>3</sup> In Sir C. Lyell's last work the theory is thus stated: "That part of the bar which attaches Portland to the mainland rests on Kimmeridge Clay, which is sometimes exposed to view during storms. The clay may have formed a shoal, and the set of the tides in the narrow channel may have arrested the course of the pebbles, which are always coming from the west."<sup>4</sup>

Colonel G. Greenwood, however, accounts for the occurrence of the Chesil bank on the supposition that, in consequence of a rise of the land, the sea would have a shallower shore, against which it could throw up the pebbles. His words are as follows: "Raised beaches exist along our south coast, and I think that it is the shallows caused by the rising of the land that has [have] allowed the accumulation of double beaches between Giens [East of Toulon] and the land, as well as between Portland and the land (Chesil beach and Smallmouth sands). . . . Nature has no sooner divided the island from the continent than, by hoisting up the land, she sets the same workman, the sea, whom she first employed to sever them [it] from the land to join them [it] to the land again."<sup>5</sup>

These three theories may be described as the sinking theory; the standing still theory (by implication, as its advocates say nothing of rise or fall), and the rising theory; each of those conditions of the

<sup>1</sup> Geological Manual, Ed. 3, 8vo. Lond., 1833, p. 80. The theory is repeated in the author's later work, the Geological Observer, 8vo. Lond. (1851), p. 65, and Ed. 2 (1853), p. 56.

<sup>2</sup> Principles of Geology, vol. i. p. 281 (1830), 1st edition.

<sup>3</sup> Proc. Inst. Civ. Eng., vol. xii. p. 542 (1853).

<sup>4</sup> Principles of Geology, Ed. 10, vol. i. p. 534 (1867).

<sup>5</sup> Rain and Rivers, Ed. 2, 8v. Lond. (1866), pp. 119, 132.

shore having been invoked in turn as best explaining the origin of the bank. Our own theory will, we believe, suit all conditions.

There is one point on which all must agree; it is that the bank could not have been formed without the huge natural groyne, or breakwater, of the Isle of Portland, which bounds it on the east, and stops the shingle in its easterly course; but beyond this we venture to differ from the explanations that have been given to account for the presence of the shingle in so anomalous a position.

The above theories rest on the supposition that the form of the neighbouring land, at the time of the formation of the bank, was much the same as now; and although the theory of Sir H. De la Beche would seem to allow that the beach might have been formed against land, and separated merely by the sinking of the land (in this case the shingle ought surely to have been driven back as the land sunk), yet the other theories imply that the bank was originally formed as a detached mass, separated from the land as now by a narrow channel of water, unlike other long tracts of shingle, which are formed against the land, and which, travel as they may, touch the land.<sup>1</sup> On the other hand, the theory that we suggest needs no such supposition, but starts with the reasonable assumption that the Chesil Bank may have been formed at first in the same way as the ordinary shingle-beaches of our coast, and that what was once an ordinary beach, banked up against the land, has been since separated, as a bank or bar, by the denudation of the land behind it, such denudation having taken place in a way that would hinder the backward motion of the shingle, and would leave a narrow channel (the present Fleet) between the bank and the land.

In order to make our theory more easily understood, it will be well to give a short description of the Chesil Bank. In doing this, we shall avail ourselves of Mr. Coode's account, which has made needless any measurements on our part; at the same time we ought to state that both of us can speak from personal knowledge of the coast and of the bank, the first named of us having done the Geological Survey mapping of that district, while the other spent great part of a summer holiday in an examination of the Dorsetshire coast.

The Chesil Bank (including under that name the whole of the continuous strip of shingle from Burton Bradstock to Portland) is the largest accumulation of shingle in this country, and more than fifteen miles long. On the N.W., for five or six miles, it touches the shore, but on the S.E., from Abbotsbury, it is divided from the main

<sup>1</sup> We are aware that at the mouths of many rivers bars of shingle stretch a long way across from one side, sometimes indeed to such an extent as to turn the rivers along the shore (between the land and the shingle), in the direction of the prevailing set of the currents, for some distance. But these are not really analogous to the Chesil Bank, where the shingle-beach is far longer, and where there is no river emptying into the sea, but only a succession of very small streams. There are also cases of shingle-banks completely damming up streams, and with a marsh or expanse of fresh-water on the land side, as at Slapton Sands, South Devon, and Cuckmere, in Sussex.

land by a shallow estuary about eight miles long, of variable breadth, but nowhere more than two-thirds and often less than a quarter of a mile wide, which is known as "the Fleet" or "Backwater" (Plate XV.) ; and for the remaining two miles, nearest to Portland, it has the sea on either side. It is with the last ten miles that we are now chiefly concerned, and to this part the following paragraph refers.

The average width at the base is 170 yards near Abbotsbury, and 200 yards at Portland. The height increases from N.W. to S.E. but the inclination of the crest is not uniform. At Abbotsbury, the crest is over 22 feet, and at Chesil over 42 feet high. Borings made down to high-water level, and sometimes lower, passed through nothing but beach (except at one place, where clay was met with deep down) : ten or fifteen feet from the surface, the shingle was generally mixed with a little sand, and the quantity of the latter increased with the depth until the whole was found to be very compact.—(Coode.)

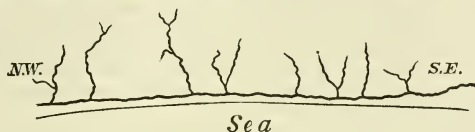
The largest pebbles are at the eastern end, and gradually decrease in size westward, until near Burton the beach consists of sand and very fine shingle. The accompanying map will make the above description clearer. (See Plate XIV.)

Westward from the end of the Bank the coast gradually gets higher, and soon there are high cliffs of Liassic, Jurassic, and Cretaceous beds. These cliffs are cut through at Burton and Charmouth by valleys with small streams, such as the Char and the Bredy, which of course flow seaward, that is in a south-westerly direction.

These streams (excepting the Bredy) do not breach the shingle of the bays where they flow into the sea, but turn eastward (the direction of the general set of the current) for a short distance, between the beach and the land, and then filter through the shingle. There is an interval of some miles between each of these successive streams, in which the cliffs are not breached by valleys, or only by such as are cut off at some height above the sea. On the other hand, along the low shelving shore eastward of Abbotsbury, the least approach to a cliff is a great rarity, and a cliff ten feet high is a marked object: here therefore the streams are much closer together, each hollow in the ground sending in its share of water to the still channel of "the Fleet."

Let us think now what would happen if in former times this latter part had been in the normal state of a beach skirting a low coast. The streamlets flowing down the small valleys would act just as those on the coast to the westward do ; that is to say, they would turn eastward for some distance before filtering through the shingle, and most likely they would run the further between the beach and the mainland, by reason of the former being so much broader, higher, and more compact than it is on the coast. Now, as the streams are near together, instead of being separated by miles of unbreached cliff, it is quite possible (and we think most likely) that some stream might continue its easterly course between the shingle and the shore,

until it reached the next stream. This might take place with several streams, where two were near together, and the increased force of two united would give the resultant stream greater power to continue its eastward course and to join on to the next. The consequence of the continuance of this process would be, that all the streams would at last join to form one long channel between the beach and the mainland, as in the subjoined Woodcut, which is on the same scale as the Map (Plate XIV.), with the streams continued to the beach.



*Plan of streams flowing to a shore where there is a current chiefly in one direction (eastward).*

It seems well within the limits of possibility that this body of water would have power enough to keep its channel free, and to prevent the firm compact shingle from being driven back against the mainland. In this case the land would be protected from the cliff-forming action of the sea, but on the other hand would be subject to the scooping action of land-waters, which would cut it back in gentle slopes, and irregularly widen the channel, according to the nature and hardness of the different beds acted on.

Of course, on any theory, the Chesil Bank could not have been formed but for the existence of the natural breakwater of Portland; and, according to the theory now brought forward, either the narrow neck of land which must once have connected Portland with the mainland, has been breached by some means or other, inwards towards Weymouth Bay (instead of the beach being breached outwards to the sea); or, on the other hand, if at first the beach was broken through, and the stream flowed out to the sea in a southerly direction, that breach must have been slight enough to have been filled by the heaping up of shingle, when the land in its rear was worn away and Portland was separated from the mainland. As the connecting isthmus must have consisted of Kimeridge Clay, its destruction would be no hard matter to the sea on one side (N.), and the stream on the other; and as large breaches in the Chesil Bank are known to have been refilled in a very short time, there is, perhaps, no great difficulty in accounting for the phenomena on either supposition.

The destruction of the land between Portland and the mainland on the north, has been made easier by the beds having been thrown into a sort of arch, with a sharp northerly and a gentle southerly dip; the arch being of course the form that helps denudation, both by fissuring the beds, and by giving them a tendency to fall outwards. In this particular case moreover the lower beds that have been brought to a higher level by the said arch, so as to be within

reach of denuding actions, are of a softer and more destructible kind than those that overlie them.

There are three facts that seem to confirm the theory that the channel in the rear of the Chesil Bank has been formed since the heaping up of the shingle:—they are (1) that the isolated part of the bank is also the largest and strongest, the best able both to withstand the sea, and to stop the streams from flowing directly into the sea: (2) that the very irregular shape and cliffless character of the shore of “the Fleet” are not such as one would expect to be caused by the action of the sea along such a coast, whilst they are just what should be produced by the action of streams: and (3) that *the Channel ends where the streams end*. Westward of Abbotsbury, where there are no streams, the beach is not separated from the land; eastward of Abbotsbury, where there are streams, the beach is separated from the land.

Whether there may have been a slight rising or sinking of the land during the formation of the beach, would we think make little difference, on the theory which we have brought forward. Whilst we are far from asserting dogmatically that the Chesil Bank must have been formed in the way described, yet we think that our theory, or explanation, involves less supposition, and tallies more with observed facts, than any other does, and that therefore it should be accepted until replaced by a better, or disproved.

Lastly, we wish to draw attention to the confirmation given to the theory of *Subaërial Denudation* by our explanation of the origin of the Chesil Bank. It was not until we were convinced of the truth of the former that we saw our way to the latter; but when we began to see how great has been the share of rain and rivers in wearing away the land, and in cutting out hills and valleys, then we were enabled, by the new light thus gained, to explain the origin of a very uncommon phenomenon, which before we could not understand or account for. What had previously been a mystery, and looked like a freak of nature, became clearly intelligible, and was seen to be the natural result of ordinary causes and existing agencies.

*Postscript.*—In the discussion of this paper, Mr. J. Evans, F.R.S., “suggested that tidal action may have assisted materially in the formation and widening of the Fleet.” This we are far from denying, although we omitted to notice in our paper the assistance that may have been given by that action when it was enabled to come into play.

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#### ON A RAISED BEACH AT PORTLAND BILL, DORSET.

By W. WHITAKER, B.A. (Lond.), F.G.S., of the Geological Survey of England.

#### [PLATE XIV.]

[A paper read before the Geological Society of London, May, 26, 1869.]

IN 1850, Mr. H. W. Bristow recorded, on sheet 17 of the Geological Survey Map, the existence of “conglomerate” and “recent stone” at Portland Bill.—(See Plate XIV. herewith.)

In 1852, Mr. C. H. Weston,<sup>1</sup> noticed the occurrence of a "marine shingle-bed" on the top of the cliff, in the following words: "This remarkable bed consists of beach-pebbles (with a few chalk-flints), rounded by continued sea action. The quarrymen said it extended about a quarter of a mile north of the Bill."

In 1860 this shingle was again noticed in Mr. R. Damon's "Handbook of the Geology of Weymouth and the Island of Portland,"<sup>2</sup> and the occurrence of "comminuted shells" recorded.

Mr. Bristow has suggested to me that the shingle-bed may have been formed by the sea dashing up pebbles from the shore below, as he has known it to do in stormy weather; but I doubt whether that action is enough to cause so large a deposit. At all events it will not do so altogether, as the shingle is in part protected from such action by a thick covering of subaërial origin. Mr. Bristow tells me that, as far as he remembers, there was no good section of the deposit at the time of his visit, which must have been before 1850.

The southern side of "Cave Hole" is the most northerly point of this beach, which is there thirty or forty feet above the sea, and about three feet thick, being capped by a good thickness of angular "head" (the waste of Purbeck and Portland beds), and consisting of pebbles of limestone, flint, and chert. Just southward is a projecting cave-worn ledge, with a rounded water-worn surface of Portland Stone bared of the old beach. The next projection shows a little of the same, but with pebbles and shells conglomerated together into a hard mass adherent to the surface of the stone, the shells being chiefly *Littorina littorea*, but *Littorina littoralis* and *Patella vulgata* also occurring.

Further southward there is less of the "head," indeed hardly any, but there are remains of very small shallow pits, most likely dug for sand, as a small hole close by passed through two or three feet of clayey soil and more than three feet of coarse sand with shells, which, as far as one can judge from position, overlies the shingle.

The old beach ends, after a course of less than 250 yards, before reaching the slight headland, where however there are traces of it in the soil.

Continuing my southerly walk, just before getting to the Beacon at the Bill, I found shells (of the same species as those mentioned above, and also *Purpura lapillus*) jammed in with limestone-rubble at the top of the low cliff (as noticed by Mr. Damon).

At the Bill there is a little shingle, which increases after turning westward, when the cliff rises a little. At one place a pit six feet deep shows that this shingle is sandy and bedded, whilst near by it is conglomerated into a hard mass at the top of the cliff, and further inland another pit has been dug to a depth of eight feet. Close by, at the cliff a little higher up, the shingle is covered by yellowish-brown loam (calcareous?) with bits of stone and with land and freshwater shells (*Bithinia*, *Pupa*). A little further the latter thickens and the former thins, but both end off at the projecting spur of rock.

<sup>1</sup> Quart. Journ. Geol. Soc., vol. viii., pp. 117, 8.

<sup>2</sup> 12mo. Lond., p. 141. Reprinted in 1864.

I believe that it is only to the part noticed in the last paragraph that Mr. Weston's remarks refer.

*Postscript.*—In the discussion of this paper, Sir C. Lyell said that he had found in this raised beach more species of shells than those above mentioned; and Mr. Prestwich said that at one spot the number of young shells was remarkably great as compared with that of older shells.

Decr 29. 1869. -

Garfield Park,  
Bracknell.

My dear Sir

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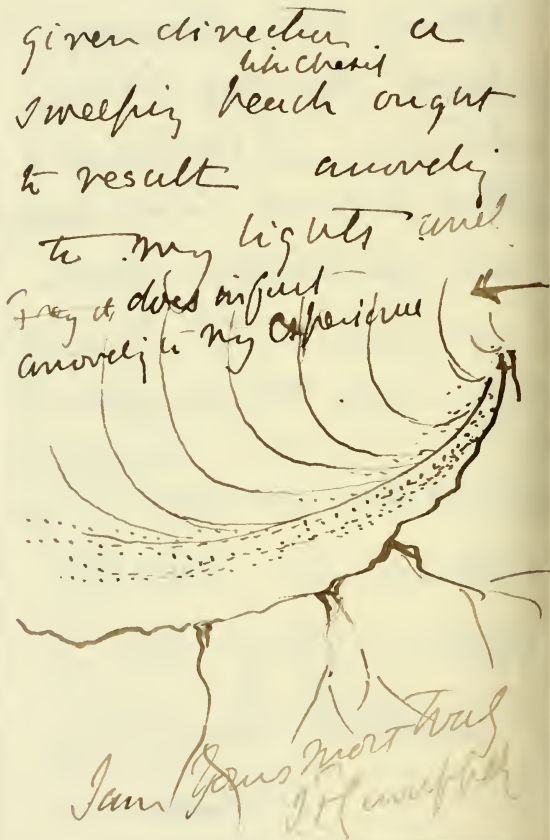
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Jan 2nd 1845  
J. H. Whitaker







